Executive Summary: Technical Working Group Final Report into LightSquared Interference with GPS

The final report of the Federal Communications Commission (FCC)-mandated Technical Working Group (TWG) clearly and conclusively demonstrates that the ground-based cellular network deployment planned by LightSquared when the TWG was formed would cause devastating interference to millions of GPS users.

The 1,000 page report, submitted to the FCC on June 30, 2011, was based on extensive testing and analysis by sub-groups of various types of GPS users, including Aviation, Cellular, General Navigation & Location, High Precision GPS, Timing and Networks, and Space based GPS. The tests of more than 100 different GPS devices were carefully conducted in laboratory, anechoic chamber and "live sky" test environments. More than 100 engineers, technical experts and advisors, representing both LightSquared and the GPS technology and user community, participated in the study and preparation of the final report.

The tests were all conducted at a 90 percent power reduction from the LightSquared's FCC authorized transmit power levels of almost 16,000 Watts[1]. Even at these drastically reduced emitted transmission levels, at the Las Vegas "live sky" tests power levels of up to ***800 billion times*** the received GPS signal were recorded next to GPS receivers on the ground at around 500 feet from a single cell tower.[2] Even a mile away from the tower, power levels up to a billion times the distant GPS signals were recorded.[3] Given typical cell tower spacing,[4] GPS users would never escape these extreme power levels anywhere within LightSquared's broadband network footprint, planned to cover 92 percent of the population within four years.[5] Even GPS receivers in outer space, 500 miles up in orbit, did not escape harmful interference from the network.[6]

The LightSquared deployment plans included in the proposed scope of the TWG effort were conclusively demonstrated to cause devastating interference to all kinds of GPS receivers tested including those used in Aviation, Cellular phones, General Location and Navigation (including Automotive, Public Safety, Personal and Marine Navigation), High Precision and Networks (including Agriculture, Surveying, Construction, Mining, Energy, Oil & Gas, Utilities, Government and Monitoring of Dams, Structures, Earthquakes and Volcanoes), and GPS Timing used in communications and broadcast networks, power grids and timing of financial transactions. The LightSquared sites were also found to jam both its own and other satellite services within the Mobile Satellite Services (MSS) band.[7] The MSS band is used in many important land- and marine-based industrial and safety applications and in safety critical maritime distress systems (GMDSS).

As the overwhelmingly negative test results became evident during the Technical Working Group process, LightSquared belatedly introduced a new proposal to use the exact same frequencies and power levels in the original test plan, but to change the order in which those frequencies are deployed, starting with the lower 10MHz channel in the band adjacent to GPS. LightSquared claims that this solves the interference problem for "99 percent of GPS receivers, including 100 percent of cell phones." However, these 99 percent and 100 percent figures are not found anywhere in the official 1,000 page TWG report, nor has LightSquared provided any data whatsoever to support these sweeping claims which arew not supported by the data.

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[1] TWG report page 48 EIRP 62 dBm (1,548W) per channel per sector tested versus authorized power of 72 dBm.(15,480W)
[2] TWG report page 276 Figure 58, peak power can be seen at -12dBm, GPS= -131dBm, 800 billion times lower.
[3] TWG report page 276 Figure 58, power levels at 1,5km or just under 1 mile =-40dBm or 1 billion times GPS at -131dBm
[4] TWG report page 259, Table 13.
[5] TWG report page 279, 2nd paragraph.
[6] TWG report Section 2.7.5 page 24 and Section 3.5 page 300.
[7] TWG report page 22, item 2)

The Aviation sub-group reported that operation in this lower 10MHz channel "could not be determined definitively to be compatible" with aviation GPS uses[8];. The General Location and Navigation and High Precision/Networks sub-groups report that[9] 20 of 29 and 33 of 33 receivers tested, respectively, still experienced harmful interference from this lower 10MHz channel. The Cellular sub-group report contains data showing that up to 10 of 41 devices[10] tested failed the defined interference test at power levels that were observed in the Las Vegas 'live sky' tests within a mile of the tower. Even GPS receivers 500 miles up in orbit were determined to still suffer interference from operations in the lower 10MHz band only, even at the 90 percent reduced power. Together, these results show that well over 50 percent of all GPS receivers tested would still suffer harmful interference from the lower 10MHz channel.

LightSquared has attempted to 'define away' the devastating interference observed, by moving the goalposts on how much interference a GPS receiver should tolerate (suggesting a massive 75% signal loss to GPS as a result of their network interference – in addition to up to 20% increase in the noise level caused by LightSquared signals 'bleeding' into the the GPS band) and by proposing 'propagation' models and other engineering assumptions that claim to limit the problem but which many of the sub-groups strongly disagreed with in the report.

Radio frequency filters were extensively investigated as a mitigation possibility. Most were theoretical concepts which could not be tested or verified as part of the study, due to the fact that they do not exist, even in prototype form. The only actual device tested was a Timing antenna with very limited uses which would filter out and lose over 96% of the GPS signal along with the LightSqaured interference Previous claims that the GPS industry had simply been using poor or cheap filters were not substantiated anywhere in the report. In fact, the results show that the high quality filters in GPS receivers can withstand interference in the adjacent band from signals many thousands or even millions of times more powerful than the GPS signals, but are overwhelmed by interfering signals billions or hundreds of billions of times more powerful.

Given that the LightSquared network consists of both satellite and terrestrial components, and given the levels of interference observed in the testing, a number of sub-groups noted that the most effective solution for all GPS receivers would be to allow LightSquared to operate its satellite communications in the MSS L-Band adjacent to GPS – serving rural, public safety and other users outside of cellular coverage areas – while operating the new dense, high powered ground based network planned for deployment in urban and suburban areas[11] in a frequency band completely outside of the MSS L-Band. Providing the satellite based services to rural and unserved areas in the MSS band adjacent to GPS would be fully compatible with adjacent GPS uses and fully consistent with the longstanding international allocation of this band to space communications. LightSquared did not conduct any exploration of this mitigation option as part of the comprehensive, five month study of interference and mitigation, despite the overwhelming evidence of the incompatibility of their terrestrial network plans with existing space-based GPS and MSS band uses.

The operational scenarios in the report[12] show that commencement of operations in the lower 10MHz MSS band could put lives at risk and would immediately risk severe disruption to many vital and critical sectors of the United States economy including agriculture, aviation, automotive, construction and engineering, personal and marine navigation, and disaster monitoring – in addition to many federal, state and local government users. While the nation needs wireless broadband, the nation also needs uncompromised GPS. A new broadband network yet to be deployed can be accommodated in frequency bands already allocated to 4G cellular services, while the GPS system and its hundreds of millions of users cannot.

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[8] TWG report page 28, 2nd para

[9] TWG report page 123 and page 180 item 5)

[10] TWG report page 77 fig 3.2.1

[11] Final report of the Technical Working Group, page 24, final paragraph reports that NASA tests regarding interference to GPS receivers in earth orbit were conducted for "a LightSquared base station deployment of approximately 34940 stations distributed among 139 major cities in the US". See also page 308, last paragraph "deployment of approximately 34940 stations distributed among 139 major cities in the US. This city data was provided by LightSquared."

[12] The implications and impacts to safety of life and critical economic and government activity are described in detail in pages 167-175, 200-214 and 274-286 of the main Technical Working Group report. A detailed economic study on the benefits of commercial GPS and the costs of disruption is available here.